A1

included on the side of the dielectric material 28 opposite the conductive strips 30. Vias 36 of conductive material are provided between the conductive strips 30 and the conductive layer 34, through the dielectric material 28. The conductive strips 32 are oriented longitudinally down the waveguide 12.

Page 12, line 20 to page 13, line 2:

A2

Holes are created through the dielectric material 28 at uniform intervals, the holes continuing through the dielectric material 28 to the conductive strips 30 on the other side. The holes can be created by various methods, such as conventional wet or dry etching. They are then filled or covered with the conductive material and the uncovered side of the dielectric material is covered with a conductive material, both accomplished using sputtered vaporization plating. The holes do not need to be completely filled but the walls of the holes must be covered with the conductive material. The covered or filled holes provide conductive vias 36 between the conductive layer 34 and the conductive strips 30. The dimensions of the dielectric material 28, the conductive strips 34 and the vias 39 depend on the particular design frequency for the waveguide 12.

Page 13, lines 3-21:

A3

With the high impedance structure 26 on the waveguide's sidewalls such that the conductive strips run parallel to the waveguides longitudinal axis, the structure will present a high impedance to the E field component of a vertically polarized signal at the design frequency. As shown in FIG. 4, the gap 32 presents a capacitance 38 to the E field component that is transverse to the conductive

strips. The capacitance 38 is primarily dependant upon the width of the gap 32 between the strips 30 but is also impacted by the dielectric constant of the dielectric material 28. The structure 26 also presents an inductance 40 to a transverse E field, the inductance 40 being dependant primarily on the thickness of the dielectric material 28 and the diameter of the vias 36. At resonant frequency, the structure presents parallel resonant L-C circuits 42 to the vertically polarized signal and, as a result, a high impedance to a transverse E field. The E field maintains uniform power density across the waveguide, during transmission through the waveguide.

Page 13, line 28, to page 14, line 13:

The wall structure 26 also has a shorting switch 39 at each of the gaps 32 that short their respective gap when closed, the details of the switches described below and shown in FIGs. 11-14. When the switches 39 are open, the structure functions as described above, presenting a high impedance to a transverse E field. The gaps 32 form the capacitive part of the resonant L-C circuits and by closing the switches 39, the gaps 32 and their capacitance are shorted. The conductive strips 30 and closed switches 39 change the characteristics of the structure 26 such that it presents as continuous conductive sheet. The waveguide 12 now has conductive sidewalls along with the conductive top and bottom walls. Because the waveguides physical dimension "A" in FIG. 2 is less than the critical dimension required for the frequency, signal transmission is cut-off and blocked. In the preferred embodiment, the switches 39 in all the waveguides of the shutter switch 10 are closed simultaneously, causing all the waveguides to block transmission of the signal.

Page 16, lines 10-18:

A5

The structure 57 is manufactured using similar materials and processes described above for the embodiment shown in FIGs. 2 and 3, and the manufacturing of the shorting switches is described below. By selectively closing the switches on opposing walls of the waveguide 50, the horizontal portion, vertical portion, or both, can be cut-off. A shutter switch constructed of these waveguides can selectively block portions of a cross-polarized beam, or the entire beam.

Page 16, line ~~12~~ 21 to page 17, line 4:

A6

FIG. 7 shows another embodiment of the waveguide 70 used to construct the shutter switch 10. The waveguide has a three-layered high impedance 71 structure its walls 72-75. In alternative embodiment the structure 71 can be on the waveguides sidewalls 72, 74 with its top and bottom walls 73, 75 being conductive, or the structure can be on the waveguides top and bottom walls 73, 75 with its sidewalls 72, 74 being conductive. The structure 71 can have different numbers of layers, depending on the number of frequencies to be transmitted by the waveguide. The structure 71 shown has three layers and presents a high impedance to transverse E fields at three different resonant frequencies.

Page 20, line 19 to page 21, line 5:

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FIGs 10a-10c illustrate how the three signals interact with layers of the new structure 71. An important

characteristic of the structure's layers 104, 106, and 108 is that each appears transparent to E fields at frequencies below its design frequency, and the strips appear as a conductive surface to E fields at frequencies above its design frequency. For the highest frequency signal f1, the top layer 108 presents as high impedance resonant L-C circuits to the signal's transverse E field. The strips 110 on second layer 106 appear as a conductive layer and become a "virtual ground" for the top layer 108. Signal f2 is lower in frequency than f1 and, as a result, the first layer 104 is transparent to f2's E field, while the second layer 106 appears as high impedance resonant L-C circuits. The strips 112 on the third layer appear as a conductive layer, becoming the second layer's virtual ground. Similarly, at f3 the top and second layers 108 and 106 are transparent, but the third layer 104 appears as high impedance resonant L-C circuits, with the conductive layer 114 being ground for the third layer 104.

Page 21, line 29, to page 22, line 12:

Shorting switches 116 are shown as symbols on the top layer of the structure 71 on the walls 72-75, and the details of the switches are described below and shown in FIGs. 11-14. If the switches are closed on the top layer on all four of the waveguide's walls, the waveguide 70 is changed from transparent to opaque at all three frequencies. For instance, at the lowest frequency, when the first two layers of the structure appear transparent and closing the switches on the top layer shorts the gap capacitance and causes the signal to see only the conductive surface presented by the top layer's conductive

strips and closed switches. The same is true for the next higher frequencies. Closing the switches causes them to see only a conductive surface, cutting off transmission.

Page 22, line 23, to page 23, line 9:

If switches 116 are included at each of the layers (not shown) then different frequencies at different polarizations can be selectively blocked. For example, f3 could be blocked in both polarizations if the switches 116 are closed on the bottom layer 82 (shown in FIG. 8) on all four walls. Only for f3 will the all the layers appear as conductive layers, cutting off transmission at f3. If the shorting switches 116 are closed on the bottom layer 82 on the top and bottom walls 73, 75 only, transmission of the horizontally polarized signal at f3 is blocked, while still transmitting the vertically polarized signals at f3. If the switches 116 are closed on the bottom layer 82 on the sidewalls, transmission of the vertically polarized signal at f3 is blocked. By selectively closing the switches 116 at the other layers 84, 86, the different frequencies in different polarizations can be blocked.

Page 23, line 25, to page 24, line 7:

FIGs. 11, 12 and 13, show one embodiment of the MEMS shorting switches 132 constructed in accordance with the present invention to short the conductive strips 134 in the high impedance structure 130. The switches 132 are fabricated using generally known micro fabrication techniques, such as masking, etching, deposition, and lift-

off. FIG. 11 is a sectional view of the high impedance structure 130 taken transverse to the conductive strips 134. FIG. 12 is a sectional view taken long sectional lines one of the shorting switches 132. Both show high impedance structure's dielectric material 136, vias 138 and conductive layer 140.

Page 24, lines 8-17:

The switches 132 are manufactured by depositing semiconductor layer 140 over the conductive strips 134 and over the exposed surface of the dielectric material 136, the preferred semiconductor material being Si_3N_4. Stand-off isolators 142 are deposited at intervals down the gap between the conductive strips 134 and are preferably formed of an insulator material such as silicon dioxide. A respective strip of metallic material 144 is mounted over each of the gaps by affixing it on the top of the stand-offs 142 along one of the gaps.

Page 24, lines 18-28:

In operation, each metallic strip 144 has either 0 volts or voltage potential applied, with the preferred potential being 50 volts. With 0 volts applied, the strips 134 remain suspended above their respective gap between the stand off isolators 142 as shown in FIG. 12. The switches are in the "Off" state and the structure 130 presents as a high impedance to the design frequency E field transverse to the conductive strips 134. The gaps between the strips 134 presents a capacitance and the vias 138 present an inductance, with the structure presenting as a series of

a11

resonant L-C circuits to the transverse E field.

Page 24, line 29 to page 25, line 10:

a12

Referring now to FIG. 13, to close the switch 132 and short the gap between conductive strips 134 a 50 volt potential is applied to the metallic strips 144. This causes an electrostatic tension between the metallic strips 144 and the respective conductive strips 134 below, pulling the switch strip down such that it makes capacitive contact with the strip 134 on each side of the gap. This provides a conductive bridge across the gap, shorting the gap. With all the metallic strips 144 pulled to the strips 134 below, the high impedance structure appears as a conductive surface to the signal's E field. This switching network consumes very little and has a very fast closure time on the order of 30 μs.

Page 25, lines 11-19:

FIG 14 shows a high impedance structure 150 with a second embodiment of the shorting switches 152 that utilize varactor diode technology to short the gaps. The varactor diode is an ordinary junction diode that relies on its voltage dependent capacitance. Each varactor switch includes a N+ (highly conducting) layer 154 grown or deposited in the each gap between the conductive strips 156. An N- (moderately conducting) layer 158 is grown on top of top of a portion of the N+ layer 154.

Page 25, lines 20-30:

In fabricating the switches 152, the N+ and N- layers 154 and 158 are etched into mesas that will provide a strip of varactor material along the length of the gaps between the conductive strips 156. The switching of the varactor is

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controlled by a second conductive strip 160 sitting on an insulator layer 162 that is sandwiched between the second strip 160 and each conductive strip 156. The insulator layer 162 provides a capacitive coupling to conductive strip 156 and the ground plane. Voltage applied to the second strip 160 controls the capacitance of the varactor layer and thus the shorting of the gap.

Page 26, lines 9-27:

a13

FIG. 15 shows millimeter beam transmission system 170 used in various high frequency applications such as munitions guidance systems (e.g. seeker radar). A transmitter 172 generates a millimeter signal 174 that spreads as it moves from the transmitter. Most of the signal is directed toward a lens 176 that collimates the signal into a beam 177 with little diffraction. The collimated beam travels to a second lens 158 that focuses the beam to a receiver 180. The shutter switch 182 is positioned between a millimeter wave transmitter 172 and receiver 180 such that it intercepts the transmission beam 177. When the shorting switches on the shutter switch's waveguides are open, the shutter switch 182 is transparent to the beam and the signal passes from the transmitter 172 to the receiver 180. When the shorting switches are closed, transmission of the signal through each of the waveguides is cut-off, making the shutter switch 182 opaque to the beam 177 and blocking transmission from the transmitter to the receiver.

Page 26, line 28, or page 27, line 2:

a14

As described above, when the waveguides in the shutter switch 182 have the high impedance structure on the